I. C. 7100 FEBRUARY 1940

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
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INFORMATION CIRCULAR

ACCIDENT EXPERIENCE AT PEBBLE-PHOSPHATE OPERATIONS IN FLORIDA, 1930-38

BY

FRANK E. CASH AND GEORGE W. COLBERT

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ACCIDENT EXPERIENCE AT PEBBLE-PHOSPHATE OPERATIONS IN FLORIDA, 1930-38[1]

By Frank E. Cash[2] and George W. Colbert[3]

INTRODUCTION

Data on the accident experience of the pebble-phosphate industry in Florida for 1937 and 1938 are combined in this report with statistics for the 7-year period 1930-36, inclusive, which were published in Information Circulars 6917[4] and 6968[5]. The periodic publication of such data enables the pebble-phosphate industry, as well as other industries, to consider relative hazards, compare experience, and thereby help to prevent accidents.

ACKNOWLEDGMENTS

Accident data were furnished by the following operating companies: Amalgamated Phosphate Co., Brewster; American Agricultural Chemical Co., Pierce; Coronet Phosphate Co., Plant City; International Agricultural Corporation, Mulberry; Phosphate Mining Co., Nichols; Southern Phosphate Corporation, Bartow; and Swift & Co. Fertilizer Works, Bartow.

Production figures are from Mineral Resources of the United States and Mineral Yearbooks.[6]

The descriptive matter was taken in part from Bureau of Mines Bulletin 298.[7]

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Inf. Circ. 7100."

2/ District engineer, Bureau of Mines Safety Station, Birmingham, Ala.

3/ Assistant safety instructor, Bureau of Mines Safety Station, Birmingham, Ala.

4/ Cash, F. E., and Dempsey, Claud P., Pebble-Phosphate Accident Experience: Bureau of Mines Inf. Circ. 6917, 1936, 10 pp.

5/ Cash, F. E., and Dempsey, Claud P., Pebble-Phosphate Mine Accident Experience: Bureau of Mines Inf. Circ. 6968, 1937, 12 pp.

6/ Bureau of Mines, Mineral Resources of the United States, 1925-31 (before 1925, data assembled by the Geol. Survey): Minerals Yearbooks, 1932-33-34-35-36-37 and 38.

7/ Cash, F. E., and von Bernewitz, M. W., Methods, Costs, and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite, and Pebble Phosphate: Bureau of Mines Bull. 298, 1929, 275 pp.

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Pebble-Phosphate Mining District

Most of the land pebble-phosphate district of Florida is in the western part of Polk County and the eastern part of Hillsborough County, but it extends south into the northwest corner of DeSota County and the northeast corner of Manatee County. The area now considered workable extends from near Plant City on the north almost to Bowling Green on the south - 30 miles in a northwest and a southeast direction, with an average width of 10 miles.

PRODUCTION

Florida produces approximately 71 percent of the phosphate mined in the United States, and 95 percent of the Florida production is from the pebble-phosphate field.

Production of land pebble phosphate in Florida was begun in 1890; the first shipment was made in 1891, and at present, under normal conditions, annual shipments amount to about 3 million long tons.8/

MINING METHODS

The phosphate conglomerate or matrix is overlain by 10 to 50 feet of sand, sandy clay, or porous, friable sandstone, which constitutes the overburden. The overburden is removed either by traction, electric dragline excavators with 120- to 165-foot booms and 6- to 10-cubic yard buckets, and "spoiled" in areas from which the matrix has been mined, or it is removed hydraulically.

The matrix, which is 5 to 20 feet thick, is mined by hydraulic "giants" or "guns" that have a nozzle pressure of 170 to 220 pounds per square inch. Before mining is begun, it is necessary to have a well, sump, or low place in which to accumulate the dislodged matrix picked up by the pumps. These wells or sumps are made by the excavator or by water pressure or are drill-blasted. After the sump is prepared and the pump connected, the bed of matrix is cut down by the hydraulic guns, flows into the sump, and is picked up by 10- and 12-inch centrifugal pumps driven electrically, handling 10 to 25 percent solids and using 2,500 to 4,000 gallons of water. If the height or distance between sump and washer becomes too great, one or more relay or booster pumps is placed in the line between the pit and washer.

WASHING, RECLAIMING, AND DRYING

The matrix is discharged into processing plants called washers, in which it is dewatered, processed to remove slimes and clay and screened to remove the sand and small pebbles of phosphate. The rejected fines

8/ Bureau of Mines, Rules Governing the Award of Trophies in the National Safety Competition for 1938.

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are reclaimed later by flotation, and the washed phosphate pebbles are loaded into cars and hauled by steam or electric locomotives to the drying plant. The rock is dried in oil-fired rotary kilns at an average temperature of 225° F. at the discharge end and conveyed by belts to classified storage bins.

FLORIDA WORKMEN'S COMPENSATION ACT

The Florida Workmen's Compensation Act, enacted by the 1935 Legislature, became effective July 1, 1935. The act is administered by the Florida Industrial Commission, consisting of a chairman, appointed by the Governor, and two other members selected from the Governor's cabinet. The total expense of administering the act is prorated and borne by insurance companies writing compensation insurance in the State and by self-insurers.

All employers and employees, except a few specifically exempted, come under the act unless they file the required notice of nonacceptance and waiver of exemption, in which case, the employer may not, in suits brought against him, use as defense negligence of a fellow servant, nor that the employee assumed the risk of his employment, nor that the injury was due to the contributory negligence of the employee; and the employee who refuses to come under the act, in any action to recover damages for injury or death brought against an employer who accepts the provisions of the act, may proceed as at common law; and the employer may avail himself of the defense of negligence of fellow servant, assumption of risk, and contributory negligence as such defense exists at common law.

Provisions are made for the employer to supply medical, surgical, hospital, and nursing attention that may be required during the period of recovery. If death results from an accident the employer must pay reasonable burial expenses, not exceeding $150.

Compensation is allowed for the first 14 days, unless the accident causes disability for more than 28 days, in which case compensation is allowed from the date of disability. The amount of compensation shall not exceed $18 per week nor be less than $4 per week unless at the time of the injury the employee's wages are less than $4 per week, when he shall receive his full weekly wage. Payments of compensation are made on the following basis: 50 percent of the average weekly wage if there are no dependents, 55 percent if one dependent, and 60 percent if more than one dependent. Payment is made for all temporary total disabilities and for the following periods in case of death or permanent disabilities: Death, 350 weeks; permanent total disability, 350 weeks; loss of arm, 200 weeks; leg, 175 weeks; hand, 150 weeks; foot, 125 weeks; eye, 100 weeks; thumb, 60 weeks; first finger, 35 weeks; great toe, 30 weeks; second finger, 30 weeks; third finger, 20 weeks; fourth finger, 15 weeks; toe other than great toe, 10 weeks; and loss of hearing one ear, 40 weeks, and both ears, 150 weeks. Loss of both hands, both arms, both legs, and both eyes constitutes permanent total disability.

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The foregoing is abstracted from House Bill 29 as enacted by the 1935 Florida Legislature.

SAFETY ORGANIZATIONS

Every company in the pebble-phosphate district has a safety director and an employees' safety organization that holds regular periodical meetings. Accidents and "near" accidents are discussed in these meetings, and suggestions are made for the prevention of future similar accidents; also, employees are encouraged to make suggestions for improving living and working conditions in and around the mines and plants.

One of the oldest and most active chapters of the Holmes Safety Association in the United States is functioning in one of these mining communities, and all matters pertaining to safety are handled by the chapter.

All of the operating companies train some of their employees in first aid each year. Most of them maintain 100-percent first-aid training annually on a cooperative basis; in other words, all employees are trained annually by company instructors under supervision of an instructor from the Safety Division of the Federal Bureau of Mines. As a part of or climax to the training, annual first-aid contests are held, with from four to six of the seven producing companies participating.

ACCIDENT EXPERIENCE

Accident data were made available by all of the operating companies; to present them on a basis comparable with other industries (taking into consideration relative hazards), total days lost will be increased in some instances, as partial permanent disabilities are carried in the district as actual days lost and fatal accidents are charged by two companies without loss of time.

Partial and total permanent-disability and fatal-accident statistics uniformly comparable with those for other industries have been converted into their equivalent of days lost, according to the scale of time losses for weighting deaths and permanent injuries to show severity of injuries used by the Federal Bureau of Mines. (See table 1.)

Tables 2 to 5, inclusive, contain accident figures for the seven phosphate companies by months, age of injured, and nature and cause of injuries; tables 6 and 7 consolidate these figures for the pebble-phosphate industry, and table 8 compares the pebble-phosphate accident experience with that of other industries.

Table 2 shows that there is relatively little difference in the number of accidents for any month of the year; the greatest number of accidents for the period 1930-36, inclusive, occurred in September and October and the smallest number in November and February; during 1937 and 1938 the greatest number occurred in December and the fewest in February.

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TABLE 1. - Scale of time losses for weighting deaths and permanent injuries so as to show severity of injuries 1/

Nature of injury 2/	Degree of disability, in percent of permanent total disability	Days lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment or loss of use	75	4,500
Arm at or below elbow, dismemberment or loss of use	60	3,600
Hand, dismemberment or loss of use	50	3,000
Thumb, dismemberment or loss of use	10	600
Any one finger, dismemberment or loss of use	5	300
Two fingers, dismemberment or loss of use	12-1/2	750
Three fingers, dismemberment or loss of use	20	1,200
Four fingers, dismemberment or loss of use	30	1,800
Thumb and one finger, dismemberment or loss of use	20	1,200
Thumb and two fingers, dismemberment or loss of use	25	1,500
Thumb and three fingers, dismemberment or loss of use	33-1/3	2,000
Thumb and four fingers, dismemberment or loss of use	40	2,400
Leg above knee, dismemberment or loss of use	75	4,500
Leg at or below knee, dismemberment or loss of use	50	3,000
Foot, dismemberment or loss of use	40	2,400
Great toe or any two or more toes, dismemberment or loss of use.	5	300
One toe, other than great toe, dismemberment or loss of use	0	- -
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

1/ Bureau of Mines, Rules Governing the Award of Trophies in the National Safety Competition for 1936, p. 3.
2/ Dismemberment means severance of any part of the bone.

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TABLE 2. - Accidents, by months, 1930-38

Month	Year	Company A	B	C	D 1/	E	F	G	Total
January	1930 - 36	10	20	3	5	3	15	4	60
	1937	1	1	1	3	0	3	0	9
	1938	0	0	1	1	2	0	0	4
February	1930 - 36	4	9	4	5	5	14	1	42
	1937	0	0	1	2	1	1	0	5
	1938	0	0	0	2	1	2	1	6
March	1930 - 36	8	11	4	6	6	15	2	52
	1937	1	0	0	4	4	0	0	9
	1938	1	0	1	0	4	2	0	8
April	1930 - 36	4	13	4	4	4	13	3	45
	1937	0	2	1	1	2	1	0	7
	1938	0	2	0	0	2	5	2	11
May	1930 - 36	7	16	1	5	4	14	2	49
	1937	0	0	0	2	0	4	0	6
	1938	0	0	1	5	5	2	0	13
June	1930 - 36	3	12	5	3	3	20	1	47
	1937	0	1	0	2	3	2	0	8
	1938	0	0	1	1	2	1	0	5
July	1930 - 36	8	8	1	11	4	20	5	57
	1937	1	3	0	1	3	7	0	15
	1938	0	0	2	1	2	1	0	6
August	1930 - 36	6	5	3	4	6	15	6	45
	1937	0	2	1	1	3	3	0	10
	1938	0	0	1	0	4	1	1	7
September	1930 - 36	5	16	2	15	14	19	8	79
	1937	0	0	1	0	3	5	0	9
	1938	0	0	0	0	3	3	0	6
October	1930 - 36	11	9	5	7	7	22	5	66
	1937	0	3	0	2	2	2	0	9
	1938	0	0	1	2	2	3	1	9
November	1930 - 36	5	3	0	4	6	14	7	39
	1937	4	0	0	0	5	1	0	10
	1938	0	0	2	2	1	3	0	8
December	1930 - 36	2	14	4	3	9	16	2	50
	1937	0	1	0	5	2	2	0	10
	1938	0	0	2	1	3	6	0	12
Total	1937	7	13	5	23	28	31	0	107
	1938	1	2	12	15	31	29	5	95
	1930 - 38	81	151	53	110	131	257	51	833

1/ 1931 - 1938.

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TABLE 3. - Age of injured, 1930-38

Age	Period	Company A	B	C	D1/	E	F	G	Total
18-28	1930 - 36	22	39	9	16	19	58	13	176
	1937	0	3	0	4	11	9	0	27
	1938	1	0	4	2	9	9	3	28
28-38	1930 - 36	24	44	8	24	18	52	19	189
	1937	2	4	2	7	9	8	0	32
	1938	0	0	3	5	11	7	0	26
38-48	1930 - 36	24	34	14	16	16	47	12	163
	1937	2	1	1	6	4	5	0	19
	1938	0	1	2	4	4	6	0	17
48-58	1930 - 36	3	17	4	15	17	39	1	96
	1937	1	3	2	5	3	7	0	21
	1938	0	1	3	4	6	5	2	21
58-68	1930 - 36	0	2	1	1	2	1	1	8
	1937	2	2	0	1	1	2	0	8
	1938	0	0	0	0	0	1	0	1
68 and over	1930 - 36	0	0	0	0	0	0	0	0
	1937	0	0	0	0	0	0	0	0
	1938	0	0	0	0	0	1	0	1
Total		81	151	53	110	130	257	51	833

1/ 1931-38.

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TABLE 4. - Parts of the body injured, 1930-38

Member	Company							Total
	A	B	C	D[1]	E	F	G	
Head	1	1	3	1	6	15	3	30
Face	1	6	-	4	3	11	2	27
Eyes	13	9	3	2/8	17	2/28	2	80
Shoulder	2	8	-	4	2	12	-	28
Arm	3	5	4	4	8	15	2	41
Wrist and hand	5	6	3	6	6	29	1	56
Fingers	2/14	20	5	3/6	27	3/34	3/7	113
Chest	2	10	3	5	2	11	2	35
Back	4	10	3	25	13	31	6	92
Pelvis	-	1	-	-	-	-	1	2
Groin	-	3	1	-	4	4	-	12
Hip	3	-	1	1	1	3	-	9
Thigh	1	-	1	1	1	1	-	5
Leg	8	11	4	11	6	13	2	55
Knee	2	9	5	2	6	3	4	31
Ankle	3	12	2	8	6	12	2	45
Foot	10	26	9	14	20	33	13	125
Toes	6	5	2	8	2/1	1	1	24
Internal	1	8	4	2	-	0	1	16
Infections	-	-	-	-	-	-	-	0
Heat	-	-	-	-	-	-	1	1
Fatal	2	1	-	-	1	1	1	6
Total	81	151	53	110	130	257	51	833

1/ 1931-38. 2/ One partial permanent. 3/ Two partial permanents.

TABLE 5. - Classification of accident causes, 1930-38

Causes	Company								Percent total
	A	B	C	D[1]	E	F	G	Total	
Handling material	12	1	14	35	23	66	17	168	20.2
Machinery	10	21	11	16	11	26	6	101	12.1
Falling persons	13	35	8	25	14	55	8	158	18.9
Hand tools	5	10	4	11	13	11	5	59	7.1
Falling material	5	32	1	2	10	20	2	72	8.6
Haulage	3	7	1	4	14	5	1	35	4.2
Nails	6	8	1	2	8	16	0	41	4.9
Burns	3	9	1	5	7	12	2	39	4.6
Electricity	1	7	0	1	5	5	3	22	2.7
Flying objects	9	3	6	2	6	18	0	44	5.3
Infections	0	0	5	1	2	2	2	12	1.5
Automotive equipment	8	0	0	2	3	2	0	15	1.8
Striking objects	2	0	0	0	1	7	1	11	1.3
Explosives	1	0	0	0	0	1	1	3	0.4
Fumes	0	0	0	3	0	1	0	4	0.5
Miscellaneous	3	18	1	1	13	10	3	49	5.9
Total	81	151	53	110	130	257	51	833	100.0

1/ 1931-38.

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TABLE 6. - Operating companies accident experience - 1930-38

Company	Average no. of men	Man-hours of exposure	Lost-time accidents	Days lost	Frequency	Severity
A						
1930-36	244	3,662,854	73	7,679	19.93	2.096
1937	195	649,602	7	1,612	10.77	2.480
1938	251	699,949	1	6,000	1.43	8.571
1937-38	223	1,349,551	8	7,612	5.93	5.638
B						
1930-36	369	7,597,432	136	11,614	17.90	1.529
1937	338	885,543	13	360	14.68	.406
1938	350	790,376	2	258	2.53	.326
1937-38	344	1,675,919	15	618	8.95	.368
C						
1930-36	121	1,874,951	36	447	19.20	.238
1937	113	292,672	5	142	17.06	.485
1938	133	285,264	12	2,701	42.11	9.477
1937-38	123	577,936	17	2,843	29.24	4.918
D[1/]						
1930-36	247	2,966,512	72	2,587	24.27	.872
1937	221	561,903	23	621	40.93	1.105
1938	206	479,101	15	403	31.31	.841
1937-38	214	1,041,004	38	1,024	36.41	.984
E[2/]						
1930-36	89	1,433,042	72	7,028	50.24	4.904
1937	241	314,240	28	719	89.11	2.289
1938	295	375,417	31	777	82.67	2.071
1937-38	268	689,657	59	1,496	85.51	2.168
F						
1930-36	189	3,828,853	197	8,200	51.44	2.142
1937	300	624,000	31	503	49.68	.806
1938	250	624,000	29	3,006	46.47	4.817
1937-38	275	1,248,000	60	3,509	48.08	2.812
G						
1930-36	306	5,407,080	46	7,588	8.51	1.404
1937	345	868,576	0	0	.00	.000
1938	317	793,446	5	60	6.31	.600
1937-38	331	1,662,022	5	60	3.01	.361

1/ 1931-36.
2/ 1935-36

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TABLE 7. - Pebble-phosphate industry's accident experience, 1930-38

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1930-38
Number of mines, washers, and plants	38	40	39	39	39	38	36	33	35	37
Production (long tons)	3,166,218	1,900,806	1,402,334	2,066,900	2,249,304	2,269,891	2,442,520	3,000,338	2,740,938	21,239,249
Average no. men employed	1,615	1,436	1,222	1,498	1,790	1,593	1,600	1,753	1,802	1,589.89
Man-hours' exposure	5,211,219	4,086,434	3,293,651	3,255,650	3,795,364	3,863,597	3,911,784	4,196,536	4,047,553	35,661,788
Lost-time accidents	100	104	47	79	90	119	92	107	95	833
Days lost-time	1,240	7,092	6,737	12,645	14,243	1,234	1,952	3,957	13,205	62,305
Frequency	19.38	25.45	14.21	24.26	23.69	30.79	23.51	25.49	23.47	23.38
Severity	.240	1.740	2.050	3.890	3.760	.319	.499	.943	3.262	1.779

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TABLE 8. - Accident frequency and severity rates, 1930-38

Year	Frequency		Severity	
	All industries[1/]	Pebble phosphate	All industries[1/]	Pebble phosphate
1930	18.47	19.38	1.97	0.240
1931	15.12	24.96	1.72	1.740
1932	13.20	14.27	1.59	2.050
1933	14.56	24.26	1.59	3.890
1934	15.29	23.45	1.70	3.760
1935	14.02	30.79	1.58	.319
1936	13.57	23.51	1.64	.499
1937	-	25.49	-	.943
1938	-	23.47	-	3.262

1/ Figures for all industries are from Accident Facts, National Safety Council.

For the 9-year period 1930-38, the greatest number of lost-time accidents occurred in September and the fewest in February.

As shown in table 3, accidents in the first three age groups are almost directly proportionate to the number employed, while in the last three groups the accidents are fewer in proportion to the men employed.

According to table 4, feet are hurt most frequently, with 125 (15 percent) of the lost time accidents; fingers are next with 113 (13.5 percent); back, third, with 92 (11 percent); and eyes, fourth, with 80 (9 percent) of the total lost-time accidents.

Company "C" has operated 9 years and employed an average of 122 men, who have worked 2,452,887 man-hours without a partial permanent or fatal accident; company "D" began operation in 1931 and has operated 8 years and employed an average of 246 men, who have worked 4,007,516 man hours without a fatal accident.

Handling material is the leading cause of lost-time accidents, with 168 (20.2 percent); falling persons is next, with 158 (18.9 percent); and machinery is third with 101 (12.1 percent). (See table 5.)

A lost-time accident is one that causes the loss of more than the shift or day on which the accident occurred.

The accident-severity rate indicates the number of calendar days of disability per thousand days worked:

$$\text{Severity} = \frac{\text{Number of days lost due to accidents}}{1{,}000}$$

The accident-frequency rates indicate the number of fatal and non-fatal lost-time injuries per million man-hours worked:

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$$\text{Frequency} = \frac{\text{Number of fatal and lost-time accidents}}{1{,}000{,}000}$$

Comparison of the frequency and severity rates for 1937 with those for the 7-year period 1930-36, inclusive, shows that five of the companies lowered or improved their frequency rates and five (not all the same) lowered or improved their severity rates. Two of the companies improved both their frequency and their severity rates. Comparing rates for 1938 with those for the same 7-year period, four companies lowered their frequency rates, four lowered their severity rates, and two lowered both their frequency and severity rates.

Comparing rates for 1937 and 1938 combined with those for the period 1930 to 1936, inclusive, four companies lowered their frequency rates, three their severity rates, and two both frequency and severity rates.

The accident experience of the pebble-phosphate industry of Florida is given in table 7. During this 9-year period, with an average of 1,589.89 men working a total of 35,661,788 man-hours, there have been 6 fatal, 17 partial permanent, and 811 other lost-time accidents. The frequency has ranged from a low of 14.21 in 1932 to a high of 30.79 in 1935, the average being 23.38.

Due to the relatively small number of men employed, the severity rate is greatly influenced by a fatality and has varied from a low of 0.240 in 1930 to a high of 3.890 in 1933, with an average of 1.779 for the 9 years.

The comparison in table 8 of the accident frequency and severity rates of the pebble-phosphate industry of Florida with those of all other industries indicates continuous unified efforts in accident prevention when relative hazards are considered.

SUMMARY

From a review of the accidents during 1937 and 1938, it would seem advisable for the individual pebble-phosphate companies of Florida to consider the following protective measures for some of the more numerous accidents:

Hard hats would have prevented most of the 11 head injuries, which caused 79 days' lost time.

Good shoes, better walk and stairways, and the proper instructions for lifting would have eliminated many of the 21 back injuries, which caused 413 days' lost time.

Although gloves are a hazard to some men in some types of work, their use would have prevented some of the 22 injuries to fingers, which caused 4,750 lost days, while stopping machinery for repairs and oiling

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and the proper guarding of belts, pulleys, and gears would have prevented others. At least half of the 34 foot and toe injuries (835 lost days) would have been prevented by wearing safety shoes, and another 20 percent would have been prevented by the use of good soles on employees' shoes and better housekeeping around plants.

The use of goggles would have prevented 80 percent of the 23 eye injuries, two of which resulted in the loss of sight of an eye, and caused 3,658 lost days.

Although all of the companies hold regular safety meetings for certain classes of their employees and thereby accomplish a great deal in accident prevention, other companies and other industries have found that one of the best means of education and training in accident prevention is through monthly safety meetings for all employees, such meetings supplementing those of employee groups or supervisors.

CONCLUSIONS

The accident experience of the pebble-phosphate industry as a whole is good but it can be improved. The various companies are making safety or accident prevention an operating aim of paramount importance, and eventually this attitude will produce results.

Analysis of the causes of accidents indicates that consideration, strengthening, or adoption of periodic safety meetings for all employees, better "job housekeeping", the use of protective clothing, and the continuous training or education of all employees, supervisors, and workmen, may be expected to improve the already good accident record of the pebble-phosphate industry of Florida.

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